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FINAL REPORT

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TISDALE FIBRE INITIATIVE

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Prepared by: Kelsey Development Corporation

RESEARCH FINDINGS

Tisdale Fibre Initiative

Kelsey Development Corporation

In Partnership with

Saskatchewan Department of Agriculture, Food and Rural Revitalization

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I. EXECUTIVE SUMMARY

OBJECTIVES

- To obtain information on the methods and associated costs of procuring an annual supply of retted flax straw for fibre processing
- To support the establishment of a flax fibre processor in the Tisdale area by providing them with more data as to the quality of retted oilseed straw that is available in the Tisdale area
- Record data on the quantity and quality of fibre from oilseed flax straw

OBSERVATIONS

- In the field, the flax yielded 23.55% fibre content, which is very high considering that oilseed varieties of flax have historically graded from 10% to 15%.
- This year was a strange growing season with unusually low temperatures and an early frost. Low temperatures were a major inhibitor to the overall retting process because straw needs heat to ret properly
- Processing delays resulted in flax bales being stacked to the side of the field and left over the winter. After winter the bales were exposed to moisture from melting snow and heavy spring rains which had a significant impact on straw quality and subsequent research findings
- Results, straight cut high, stubble disk bined
  Straw had a poor degree of retting at 1.0 (a perfect score being 3.8); it contained many seed holders; and it contained mixed & short stem lengths up to 8". Not much fibre was recoverable after going through the processing plant with only 9% being recoverable after four passes. Fibre was of very weak strength and processing had to stop after four passes because too little rough fibre was coming out of the machines. There are also significant cost implications to the farmer with this option, estimated at $12.37 per acre plus possible raking
- Results, dropped behind combine without hammers
  Straw had the lowest degree of retting at 0.67; seed holders and seed bolls were present; and it contained variable stem lengths, many 7-8". Fibre was of strong strength and 77% of fibre was recoverable after one pass, 58% after 5 passes, and 36% after 10 passes. Poor to very low quality fibre and shive were produced. Shives were of good consistency and after 10 passes were quite consistent. There are zero cost implications to the farmer for this option

- Results, straight cut high, pea rolled
  Straw had the highest degree of retting at 1.3 (still poor); contained some seed holder and seed boll clumps; and it contained stem lengths 8-12". Fibre was of strong strength and 81% of fibre was recoverable after one pass, 46% after 5 passes and 41% after 10 passes. Poor to very low quality fibre and shives were produced. Shives were of reasonable consistency aside from "clumps". There are some cost implications to the farmer with this option, estimated at $3.97 per acre plus possible raking

- Results, dropped behind combine with hammers
  Straw had poor degree of retting at 1.1; presence of seed holders and bolls was less obvious; it contained variable stem lengths but many were 8-10". Fibre was of very strong strength and 82% of fibre was recoverable after one pass, 53% after 5 passes and 49% after 10 passes. Poor to very low quality fibre and shives were produced. It was hard to get clean samples of fibre or shives, and shives were quite uneven in consistency and ranged in piece sizes. There are zero cost implications to the farmer for this option

CONCLUSIONS

- The method of disk-bining is the highest cost operation and provided the worst quality material for fibre production

- Pea rolling was the top performer, yielding the highest retting quality (1.3) and longest stem lengths (8-12 inches). This does come at a small cost and it is noted that pea rolling did not break straw off very well in the field; it is believed that climactic conditions play a role in the breakability of straw in the field

- Its interesting to note that combined straw going through the hammers showed better retting than combined straw not going through the hammers

- The biggest lesson learned is not related to the research objectives and has to do with bale storage. Inadequate bale storage greatly degraded straw quality and played a significant role in the research results. We've subsequently looked deeper at bale storage issues and learned that it's also a big concern for both Schweitzer Mauduit and Durafibre. As per ourselves, both organizations also overlooked the significance of proper bale storage and have subsequently been tarping or blowing straw over bales to protect them from weathering

- Because of the problems with late harvest, inadequate bale storage, and processing capacity, it's recommended that more research trials be carried out

II. TECHNICAL REPORT

OBJECTIVES

- To obtain information on the methods and associated costs of procuring an annual supply of retted flax straw for fibre processing
- To support the establishment of a flax fibre processor in the Tisdale area by providing them with more data as to the quality of retted oilseed straw that is available in the Tisdale area
- Record data on the quantity and quality of fibre from oilseed flax straw

PROJECT ACTIVITIES AND OBSERVATIONS

Location

- In the summer of 2004, sixteen acres of bethone flax production were set aside at Fenton Farms in the Rural Municipality of Tisdale to conduct flax fibre research

Fibre content

- Flax straw samples were collected in the field to determine their fibre contents. Approximately 100 randomly selected samples were collected from the area and submitted to Biolin Research for fibre analysis just after cutting
- The flax yielded 23.55% fibre content, which is very high considering that oilseed varieties of flax have historically graded from 10% to 15%. Fibre content is a major cost factor for a processing plant and lower fibre percentages means more flax is needed for processing to obtain the same amount of fibre for finished product. Flax fibre contents can in many ways be compared to protein content as a price setter for barley

Harvesting

- The value of fibre is heavily influenced by qualitative factors such as colour and fibre strength. Fibre strength and colour are heavily influenced by the retting process which is dependant upon harvesting methods and weather conditions. A number of harvesting methods were employed and evaluated by both cost considerations and quality of fibre produced. Harvesting options explored:

    1) Flax straight cut low; straw dropped behind combine unhammered

    2) Flax straight cut low; straw dropped behind combine with hammers

    3) Flax straight cut high; standing straw stubble disk-bined

    4) Flax straight cut high; standing straw pea rolled

- Four acres strips were harvested under each method, during which the area was staked out to demark what straw had been combined and by what type of method

Retting

- Flax was a combined in late September and left to ret until late October/early November at which point all samples were baled (square bales) and tagged to denote the method of harvest employed. This was a reasonable amount of time to give for retting, although it could have been a bit longer

- This year was a strange growing season with unusually low temperatures and an early frost. Low temperatures were a major inhibitor to the overall retting process because straw needs heat in order to ret properly

- Biolin's commented that "last year (2004) was, as you know, a year of extremes. There were extremely low growing season heat units, and an extremely early frost that did more than normal damage; flax that remained unusually green late into the fall (and even started blooming again); an unusually heavy snow in October and then unusually warm weather in November. In terms of most of the straw samples we collected from research plots in Saskatchewan and Manitoba, last fall was the worst year, in the last eight, for retting. Flax stems often remained green (due to frost and many cloudy days) until late October and the weather was often neither warm nor wet."

Winter delay

- Transportation of the bales to Biolin Research for final processing and analysis should have taken place in the fall of 2004 but Biolin didn't receive critical equipment necessary to perform the research

- All flax bales were stacked to the side of the field and left over the winter for Biolin to resolve its research capacity issues

Fibre Processing

- Biolin received research equipment in the summer of 2005, at which time the bales were transported to Saskatoon for analysis. Biolin's commented were that, "although SaskFlax and Biolin were promised funding in January of 2005 for development of the pilot plant we still have not got an agreement signed and hence have not been able to procure some of the equipment needed to get cleaner samples of fibre and shives and to do quantifiable tests on them. Hence, for the time being, we can only assess some properties by using qualitative judgements and words like "very strong", "strong", "moderate", "weak" and "very weak". This is not very objective, but this is the best we can do at this time, without appropriate equipment."

- Biolin received our material and samples were cleaned, stored, retted and fibre content determination completed

- During the spring of 2005, the bales were exposed to heavy rains which significantly deteriorated the quality of our material and had a critical impact on our research findings

- Biolin commented that, "when we received your bale samples most, but not all of them were dry, but in poor condition. Your straw, for the most part, got weathered and rotted but did not ret very much. In the Fried Shake Test for the degree of retting, optimally retted flax straw would score 3.0; most of your straw scored 1.3 or less. However on processing, much of your straw broke apart (especially the disk bined material) and had the appearance and odour of having partially rotted instead of having retted. The disk bined straw was so rotted that after the fourth pass only about 9% of the starting material actually came out the end of the machine as 'fibre-like material'. (This is quite amazing considering that the original unretted straw had over 20% fibre content)."

- Processing methodology included an examination of straw. Small hand samples were taken from a variety of places within the straw lot to give a good representation of the total lot of straw. This was divided into 2 bags and each bag

labelled. One bag represented the starting material and the remaining bag was archived. The starting material went through a fried shake test to measure the degree of retting (a score of 3.0 is perfect and fully retted). They were then exposed to various qualitative examination and results reported

- Processing methodology included an examination of fibre. Straw was run through a pilot plant process which included machines for opening, spreading, crushing, and cleaning. Three bales were run through the process, with the first bale going through once, the second going through five times, and the third bale going through ten times. The resulting fibre and shives were exposed to various qualitative examination and results reported. Research per each harvesting technique is as follows:

a) Straight cut high; Stubble disk bined

Straw attributes

- degree of retting (fried shake test) was 1.0;
- straw felt wirey, coarse, and rough;
- uneven stem diameters, some big up to 2.5 mm diameter;
- many seed holders;
- some exposed fibre;
- yellow/medium brown colour;
- strong moldy odor;
- mixed & short stem lengths up to 8";
- lots of broken stem pieces;
- Significant cost implications to the farmer; disc-bine operations with an 80 hp tractor estimated at $12.37 per acre + possible raking

Fibre attributes

- light processing (one pass): 9% fibre and 91% shives;
- standard processing (five passes); 6% fibre and 94% shives;
- excessive processing (ten passes): 9% fibre and 91% shives;
- had to stop processing after 4th run because too little rough fibre was coming out of the machine;
- poor to very low quality fibre and shive produced; only suitable for paper and low end composites;
- many shives remaining on fibre; moderately attached to the fibre;
- strong odor;
- dark beige/grey colour;
- weak fibre strength;
- moderate fibre fineness;
- moderate mildew

Shive attributes

- strong odor;
- dark beige/grey color;
- some big pieces;
- lots of dust;
- Very uneven consistency;
- very uneven sized pieces

b) Dropped behind combine; without hammers

Straw attributes

- degree of retting (fried shake test) was 0.67;
- straw felt rough, hard, and coarse;
- very uneven stem diameters, 1.0 to 4.4 mm;
- seed holders and seed bolls present;
- medium to dark colour;
- odour was mildewy to ok;
- stem lengths variable, many 7-8";
- some broken stem pieces;
- not consistent between bales;
- Zero cost implications to the farmer

Fibre attributes

- light processing (one pass): 77% fibre and 23% shives;
- standard processing (five passes); 58% fibre and 42% shives;
- excessive processing (ten passes): 36% fibre and 64% shives;
- poor to very low quality fibre and shive produced;
- some shives remaining on fibre; moderately attached to the fibre; more seed holders than disc-bine;
- moderate odor;
- dark beige/yellow color;
- strong fibre strength;
- coarse fibre fineness;
- moderate mildew

Shive Attributes

- moderate odor;
- dark beige/grey color;
- very few big pieces;
- lots of dust;
- good consistency; shives after 10 passes were quite consistent;
- generally small and even sized pieces

c) Straight cut high; pea rolled

Straw attributes

- degree of retting (fried shake test) was 1.3;
- straw felt rough, coarse, and hard;
- very uneven stem diameters .33 to 2.3 mm;
- some seed holder and seed boll clumps
- dark brown colour with mildew patches;
- strong mildew odour;
- stem lengths 8-12";
- not as many broken stem pieces;
- lots of mildew;
- Some cost implications to the farmer with pea rolling operations estimated at a cost of 3.97 per acre + possible raking

Fibre attributes

- light processing (one pass): 81% fibre and 19% shives;
- standard processing (five passes); 46% fibre and 54% shives;
- excessive processing (ten passes): 41% fibre and 59% shives;
- hard to get clean samples of fibre and shive;
- poor to very low quality fibre and shive produced;
- some shives remaining; strongly attached to the fibre; more seed holders than disc-bine;
- strong odor;
- dark beige/yellow color;
- strong fibre strength;
- moderate fibre fineness;
- heavy mildew

Shive attributes

- moderate odor;
- dark beige/grey color;
- some big pieces;
- lots of dust;
- reasonable consistency aside from "clumps";
- generally small and even sized pieces after 10 passes

d) Dropped behind combine; with hammers

Straw attributes

- degree of retting (fried shake test) was 1.1;
- straw felt hard and coarse;
- stem diameters were more even than other tags;
- presence of seed holders and bolls was less obvious;
- heavy mildew and dust;
- dark beige color with grey mildew;
- mildewy odor;
- stem lengths vary but many are 8-10";
- broken stem pieces in clumps;
- Zero cost implications to the farmer

Fibre attributes

- light processing (one pass): 82% fibre and 18% shives;
- standard processing (five passes); 53% fibre and 47% shives;
- excessive processing (ten passes): 49% fibre and 51% shives;
- hard to get clean samples of fibre and shive;
- poor to very low quality fibre and shives produced;
- some shives remaining; weakly attached to the fibre; seed holders have entangled some shives and fibre together;
- strong odor;
- light beige/grey color;
- very strong fibre strength;
- very coarse fibre fineness;
- heavy mildew

Shive attributes

- moderate odor;
- dark beige/grey color;
- some big pieces;
- lots of dust;
- quite uneven consistency;
- wide range of piece sizes

- Pilot processing was able to extract fibre percentages as high as 82% even though the original fibre content of the straw was only 23%. This is due in part to the retting process and the subsequent loss of shives during bailing, storage, and transportation. Processed fibre should not, however, be considered to be pure fibre but rather a combination of flax fibre, shives, and some dust/waste material

- Biolin pointed out that, "the straw and fibre samples we produced were not pure fibre or pure shive. They are mixtures. This is due to at least three major reasons. The first is that we do not have all the machines we should have to do a final cleaning of fibre and shives. The second is that much of the straw in the samples you sent was partly rotted and many pieces of fibre fell in with the shives and many shives fell in with the fibre. The third is that all the straw had significant amounts of seed holders (i.e., the tiny wirey and often branched stems below the seed bolls). Seed holders get entangled with fibre and shives and produce "clumps" that are mixtures of fibre and shive that cannot be easily separated."

- Increased processing activity typically stripped more shives from the straw, providing more shives and less marketable fibre. The remaining fibre and shives were generally cleaner and of higher quality

Market Assessment

- Because of the straw weathering and subsequent poor quality of fibre produced, we decided not to send any material to market for price analysis. It was felt that this could have a detrimental impact on the marketplace by instilling false perceptions of fibre quality that can be produced in Saskatchewan

- Biolin's verbal assessment was that, "most of your sample straw would make reasonable fuel (although some is too rotted); some might be good for use in making paper or low end plastic composites. Some of the shives would make good horticulture mulch but the rotted smell and dark colour would make most of your shive unsuitable for higher end livestock bedding"

CONCLUSIONS

- The method of disk-bining is the highest cost operation and provided the worst quality material for fibre production

- Pea rolling was the top performer, yielding the highest retting quality (1.3) and longest stem lengths (8-12 inches). This does come at a small cost and it is noted that pea rolling did not break straw off very well in the field; it is believed that climactic conditions play a role in the breakability of straw in the field

- It's interesting to note that combined straw going through the hammers showed better retting than combined straw not going through the hammers. Although straw going through the hammers showed improved retting, after processing the shive material it produced was more inconsistent in both uniformity and piece size

- The biggest lesson learned is not related to the research objectives and has to do with bale storage. Inadequate bale storage greatly degraded straw quality and played a significant role in the research results. We've subsequently looked deeper at bale storage issues and learned that it's also a big concern for both Schweitzer Mauduit and Durafibre. As per ourselves, both organizations also overlooked the significance of proper bale storage and have subsequently been tarping or blowing straw over bales to protect them from weathering

- Biolin suggests that, "perhaps your experience last year is a good lesson in what not to do. Since I know, from previous experience, that rolling straw and disc bining straw can, under the right conditions, produce well retted straw that can produce good quality fibre, I hope you will not make a blanket statement or conclusion that rolling straw or disc bining gives worse quality than just dropping it out of the combine. However, it is obvious that the combination of machine operations, how they were operated, the type of weather conditions and the storage system used can spoil straw that has very good potential as a source of higher quality fibre (e.g., lumpy straw from a disk bine mower that is stored in wet conditions does not ret – it ROTS if it is wet too long – and it does not matter what kind of machines made the lumps). Hence, do not condemn the principles; instead condemn the particular combinations that were used to produce the straw we tested."

- Because of the problems with late harvest, inadequate bale storage, and processing capacity, it's recommended that more research trials be carried out

III. PERSONNEL

Kelsey Development Corporation

- Coordinator for the project. Kelsey was responsible for directing the project including assessing operations; directing field operations; selecting, labelling, packaging and storing of field samples; coordinating processing activity; and final report writing.

Saskatchewan Agriculture and Food

- The Tisdale Agriculture Business Centre provided in-kind contributions to the project through the Agri-Business Development Specialist, Leroy Bader. Activities included assisting with field operations; assessing operations; selecting, labelling, packaging, storing, and transporting samples.

Fenton Seed Farm Ltd.

- Contracted to do such operations as combining flax for fibre tests, discbine mowing, rolling, raking, bailing, and stacking flax straw.

Biolin Research Incorporated

- Biolin Research was contracted to do all processing activity and also did the technical analysis for qualitative and quantitative fibre assessment.

IV. EQUIPMENT

- All equipment was contracted through Fenton Seed Farm Ltd. All rates were based on the 2004 Custom and Rental Rate Guide.

- No equipment was purchased for the fulfillment of this project

V. PROJECT PHOTOS

- Some photos were taken of the project. They are in electronic format and can be made available at any time if desirable